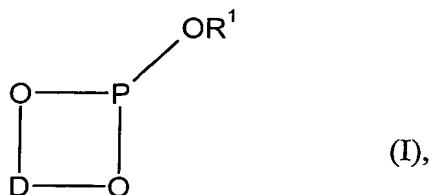


Claims:

1. Process for preparing compounds of the formula (I)



5 where

D is an unsubstituted or substituted 1,1'-biphenyl-2,2'-diyl- or 1,1'-binaphthyl-2,2'-diyl radical and

10 R¹ is a radical selected from the group of C₁-C₁₂-alkyl, C₂-C₁₂-alkenyl, C₁-C₁₂-halogenalkyl, C₅-C₁₅-arylalkyl and C₄-C₁₄-aryl, with the proviso that

R¹ has a molar mass of 215 or less,

15

comprising

in a step a) reacting

- compounds of the formula (II),

20



where Hal is in each case independently chlorine, bromine or iodine,

25

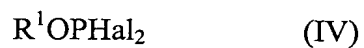
- with compounds of the formula (III),



where

R^1 is as defined above

5 to give compounds of the formula (IV)



where

10

R^1 and Hal are each as defined above,

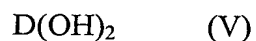
in a step b) distillatively purifying
the compounds of the formula (IV) of a) and

15

in a step c), reacting
the compounds of the formula (IV), purified in step b)

with compounds of the formula (V)

20



where

25 D is as defined above

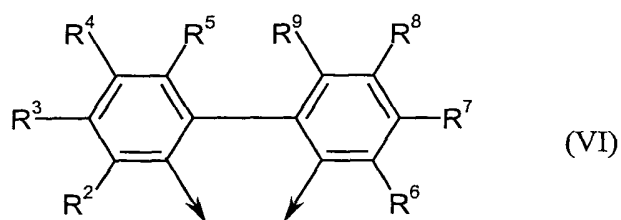
to give compounds of the formula (I).

30 2. Process according to Claim 1, characterized in that step c) is carried out in the presence of a base.

3. Process according to at least Claim 1, characterized in that R^1 is a radical which is selected from the group of C_1 - C_8 -alkyl, C_5 - C_{15} -arylalkyl and C_4 - C_{14} -aryl, with the proviso that

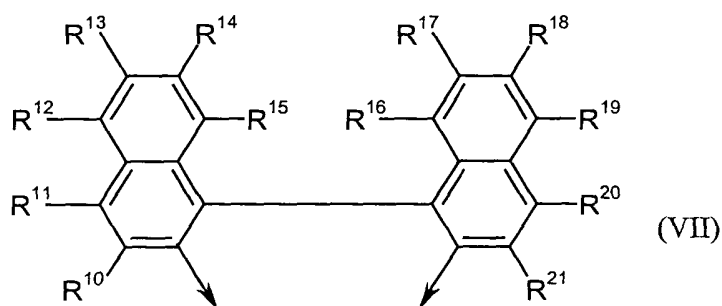
5 R^1 has a molar mass of 200 or less.

4. Process according to Claim 1, characterized in that D is an unsubstituted or substituted 1,1'-biphenyl-2,2'-diyl radical of the formula (VI)



10

or is an unsubstituted or substituted 1,1'-binaphthyl-2,2'-diyl radical of the formula (VII)



15

where the radicals

20 R^2 to R^{20} are in each case independently selected from the group of hydrogen, fluorine, chlorine, bromine, cyano, protected hydroxyl, C_1 - C_{12} -alkyl, C_1 - C_{12} -halogenalkyl, C_1 - C_{12} -alkoxy, C_1 - C_8 -alkylthio, free or protected

formyl, C₄-C₁₄-aryl, tri(C₁-C₈-alkyl)siloxyl or radicals of the formula (VIII)



5

where, each independently,

A is absent or is a C₁-C₈-alkylene radical and

10

B is absent or is oxygen, sulphur or NR²¹

where

15

R²¹ is hydrogen, C₁-C₁₂-alkyl or C₄-C₁₄-aryl and

E is a carbonyl group and

F is R²², OR²², NHR²³ or NR²³R²⁴

20

where

R²² is C₁-C₁₂-alkyl or C₆-C₁₀-aryl and

25

R²³ and R²⁴ are each independently C₁-C₈-alkyl or C₄-C₁₄-aryl, or NR²³R²⁴ together is a cyclic amino radical having 4 to 12 carbon atoms, and in each case two adjacent radicals from R² to R²⁰ together optionally form a non-aromatic ring and in each case two of the radicals from R² to R²⁰ optionally are bridging.

30

5. Process according to Claim 1, characterized in that enantiomerically enriched compounds of the formula (V) are used.

6. Process according to Claim 1, characterized in that the compounds of formula (I) are selected from the group consisting of :

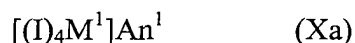
- ((S)-5,5'-dichloro-6,6'-dimethoxy-1,1'-biphenyl-2,2'-diyl)isopropyl phosphite
 ((R)-5,5'-dichloro-6,6'-dimethoxy-1,1'-biphenyl-2,2'-diyl)isopropyl phosphite
 ((R)-5,5'-dichloro-6,6'-dimethoxy-1,1'-biphenyl-2,2'-diyl)-(R)-1-phenylethyl phosphite
 ((R)-5,5'-dichloro-6,6'-dimethoxy-1,1'-biphenyl-2,2'-diyl)-(S)-1-phenylethyl phosphite
 ((S)-5,5'-dichloro-6,6'-dimethoxy-1,1'-biphenyl-2,2'-diyl)-(R)-1-phenylethyl phosphite
 ((S)-5,5'-dichloro-6,6'-dimethoxy-1,1'-biphenyl-2,2'-diyl)-(S)-1-phenylethyl phosphite
 ((S)-5,5'-dichloro-6,6'-dimethoxy-1,1'-biphenyl-2,2'-diyl)cyclohexyl phosphite
 ((R)-5,5'-dichloro-6,6'-dimethoxy-1,1'-biphenyl-2,2'-diyl)cyclohexyl phosphite
 ((S)-5,5'-dichloro-6,6'-dimethoxy-1,1'-biphenyl-2,2'-diyl)phenyl phosphite
 ((R)-5,5'-dichloro-6,6'-dimethoxy-1,1'-biphenyl-2,2'-diyl)phenyl phosphite
 ((S)-5,5'-dichloro-6,6'-dimethoxy-1,1'-biphenyl-2,2'-diyl)-2,6-dimethylphenyl phosphite
 ((R)-5,5'-dichloro-6,6'-dimethoxy-1,1'-biphenyl-2,2'-diyl)-2,6-dimethylphenyl phosphite
 ((S)-5,5',6,6'-tetramethyl-3,3'-bis(tert-butyl)-1,1'-biphenyl-2,2'-diyl)-isopropyl phosphite

- ((R)-5,5',6,6'-tetramethyl-3,3'-bis(tert-butyl)-1,1'-biphenyl-2,2'-diyl)-isopropyl phosphite
- ((S)-5,5',6,6'-tetramethyl-3,3'-bis(tert-butyl)-1,1'-biphenyl-2,2'-diyl)-(rac)-1-phenylethyl phosphite
- 5 ((R)-5,5',6,6'-tetramethyl-3,3'-bis(tert-butyl)-1,1'-biphenyl-2,2'-diyl)-(rac)-1-phenylethyl phosphite
- ((S)-5,5',6,6'-tetramethyl-3,3'-bis(tert-butyl)-1,1'-biphenyl-2,2'-diyl)-(S)-1-phenylethyl phosphite
- 10 ((R)-5,5',6,6'-tetramethyl-3,3'-bis(tert-butyl)-1,1'-biphenyl-2,2'-diyl)-(S)-1-phenylethyl phosphite
- ((S)-5,5',6,6'-tetramethyl-3,3'-bis(tert-butyl)-1,1'-biphenyl-2,2'-diyl)-(R)-1-phenylethyl phosphite
- ((R)-5,5',6,6'-tetramethyl-3,3'-bis(tert-butyl)-1,1'-biphenyl-2,2'-diyl)-(R)-1-phenylethyl phosphite
- 15 ((S)-5,5',6,6'-tetramethyl-3,3'-bis(tert-butyl)-1,1'-biphenyl-2,2'-diyl)-diphenylmethyl phosphite
- ((R)-5,5',6,6'-tetramethyl-3,3'-bis(tert-butyl)-1,1'-biphenyl-2,2'-diyl)-diphenylmethyl phosphite
- ((S)-5,5',6,6'-tetramethyl-3,3'-bis(tert-butyl)-1,1'-biphenyl-2,2'-diyl)methyl phosphite
- 20 ((R)-5,5',6,6'-tetramethyl-3,3'-bis(tert-butyl)-1,1'-biphenyl-2,2'-diyl)methyl phosphite
- ((S)-5,5',6,6'-tetramethyl-3,3'-bis(tert-butyl)-1,1'-biphenyl-2,2'-diyl)-2,6-dimethylphenyl phosphite
- 25 ((R)-5,5',6,6'-tetramethyl-3,3'-bis(tert-butyl)-1,1'-biphenyl-2,2'-diyl)-2,6-dimethylphenyl phosphite
- ((S)-5,5',6,6'-tetramethyl-3,3'-bis(tert-butyl)-1,1'-biphenyl-2,2'-diyl)-2,6-diiso-propylphenyl phosphite
- 30 ((R)-5,5',6,6'-tetramethyl-3,3'-bis(tert-butyl)-1,1'-biphenyl-2,2'-diyl)-2,6-diiso-propylphenyl phosphite

- ((S)-5,5',6,6'-tetramethyl-3,3'-bis(tert-butyl)-1,1'-biphenyl-2,2'-diyl)phenyl phosphite
 ((R)-5,5',6,6'-tetramethyl-3,3'-bis(tert-butyl)-1,1'-biphenyl-2,2'-diyl)phenyl phosphite
 5 ((S)-5,5',6,6'-tetramethyl-3,3'-bis(tert-butyl)-1,1'-biphenyl-2,2'-diyl)ethyl phosphite
 ((R)-5,5',6,6'-tetramethyl-3,3'-bis(tert-butyl)-1,1'-biphenyl-2,2'-diyl)ethyl phosphite
 10 ((S)-5,5',6,6'-tetramethyl-3,3'-bis(tert-butyl)-1,1'-biphenyl-2,2'-diyl)-4-tert-butylphenyl phosphite
 ((R)-5,5',6,6'-tetramethyl-3,3'-bis(tert-butyl)-1,1'-biphenyl-2,2'-diyl)-4-tert-butylphenyl phosphite
 ((S)-1,1'-binaphthyl-2,2'-diyl)isopropyl phosphite
 ((R)-1,1'-binaphthyl-2,2'-diyl)isopropyl phosphite
 15 ((S)-1,1'-binaphthyl-2,2'-diyl)neopentyl phosphite
 ((R)-1,1'-binaphthyl-2,2'-diyl)neopentyl phosphite
 ((S)-1,1'-binaphthyl-2,2'-diyl)phenyl phosphite
 ((R)-1,1'-binaphthyl-2,2'-diyl)phenyl phosphite
 ((S)-1,1'-binaphthyl-2,2'-diyl)benzyl phosphite and
 20 ((R)-1,1'-binaphthyl-2,2'-diyl)benzyl phosphite.
7. Process according to Claim 1, characterized in that the distillation in step b) is carried out a pressure from 0.001 to 1000 hPa.
- 25 8. Process according to Claim 1 further comprising as step d), reacting the compounds of the formula (I) obtained in steps a) to c) with transition metal compounds.
9. Process according to Claim 8, characterized in that solutions of compounds of the formula (I), as obtained in step c), are used directly in step d), optionally after removing precipitates.
- 30

10. Process according to Claim 8, characterized in that solutions of compounds of the formula (I), as obtained in step c), are concentrated, optionally after removing precipitates, the compounds of the formula (I) are taken up again in solvents and subsequently provided for reaction in step d).

11. Process according to Claim 8, characterized in that transition metal compounds containing compounds of the formula (I) are those of the formula (Xa),



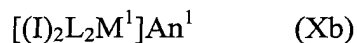
where

(II) is in each case independently, a compound of the formula (I) and

M^1 is rhodium or iridium and

An^1 is methanesulphonate, trifluoromethanesulphonate, tetrafluoroborate, hexafluorophosphate, perchlorate, hexafluoroantimonate, tetra(bis 3,5-trifluoromethylphenyl)borate or tetraphenylborate or

those of the formula (Xb)



where

(II) is in each case independently a compound of the formula (I) and

M^1 is rhodium or iridium and

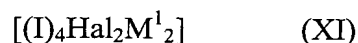
An¹ is methanesulphonate, trifluoromethanesulphonate, tetrafluoroborate, hexafluorophosphate, perchlorate, hexafluoroantimonate, tetra(bis 3,5-trifluoromethylphenyl)borate or tetraphenylborate and

5 L is in each case a C₂-C₁₂-alkene, or

L₂ together is a (C₄-C₁₂)-diene and

those of the formula (XI)

10



where

(I) is in each case independently a compound of the formula (I) and

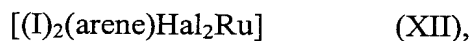
15

M¹ is rhodium or iridium and

Hal is chlorine, bromine or iodine or

20

those of the formula (XII)



where

25

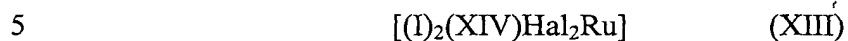
(I) is in each case independently a compound of the formula (I) and

arene is a coordinated aromatic compound having 6 to 12 ring carbon atoms which is optionally substituted by up to 6 radicals which are each independently selected from the group of C₁-C₈-alkyl, benzyl and phenyl and

30

Hal is chlorine, bromine or iodine, or

those of the formula (XIII)

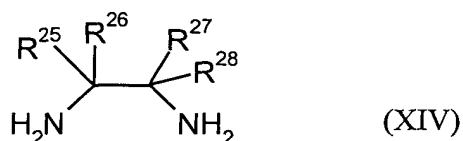


where

(I) is in each case independently a compound of the formula (I) and

Hal is chlorine, bromine or iodine,

(XIV) represents compounds of the formula (XIV)



where

R^{25} , R^{26} , R^{27} and R^{28} are each independently hydrogen, C_1 - C_{12} -alkyl, C_4 - C_{14} -aryl or C_5 - C_{15} -arylalkyl radicals, or in each case two radicals together are a straight-chain or branched C_3 - C_{12} -alkylene radical.

20

12. Transition metal complexes of the formula (Xa)



where

25

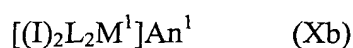
(I) is in each case independently a compound of the formula (I) as defined in Claim 1 and

M^1 is rhodium or iridium and

An¹ is methanesulphonate, trifluoromethanesulphonate, tetrafluoroborate, hexafluorophosphate, perchlorate, hexafluoroantimonate, tetra(bis 3,5-trifluoromethylphenyl)borate or tetraphenylborate.

5

13. Transition metal complexes of the formula (Xb)



10

where

(I) is in each case independently a compound of the formula (I) as defined in Claim 1 and

15

M¹ is rhodium or iridium and

An¹ is methanesulphonate, trifluoromethanesulphonate, tetrafluoroborate, hexafluorophosphate, perchlorate, hexafluoroantimonate, tetra(bis 3,5-trifluoromethylphenyl)borate or tetraphenylborate and

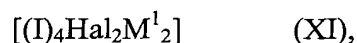
20

L is in each case a C₂-C₁₂-alkene, for example ethylene or cyclooctene, or a nitrile, , or

L₂ together is a (C₄-C₁₂)-diene,.

25

14. Transition metal complexes of the formula (XI)



where

30

(I) is in each case independently, a compound of the formula (I) as defined in Claim 1 and

M¹ is rhodium or iridium and

5

Hal is chlorine, bromine or iodine.

15. Transition metal complexes of the formula (XII)

10



where

(I) is in each case independently a compound of the formula (I) as defined in Claim 1 and

15

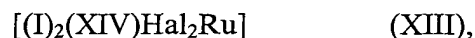
arene is a coordinated aromatic compound having 6 to 12 ring carbon atoms which is optionally substituted by up to 6 radicals which are each independently selected from the group of C₁-C₈-alkyl, benzyl and phenyl.

20

Hal is chlorine, bromine or iodine.

16. Transition metal complexes of the formula (XIII)

25



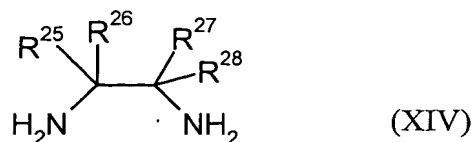
where

(I) is in each case independently, a compound of the formula (I) and

30

Hal is chlorine, bromine or iodine,,

(XIV) represents compounds of the formula (XIV)



where

5

R²⁵, R²⁶, R²⁷ and R²⁸ are each independently hydrogen, C₁-C₁₂-alkyl, C₄-C₁₄-aryl or C₅-C₁₅-arylalkyl, or in each case two radicals together are a straight-chain or branched C₃-C₁₂-alkylene radical.

- 10 17. A process for catalyzing reactions comprising providing transition metal complexes according to Claim 12 as catalysts.
- 15 18. A process for preparing stereoisomerically enriched compounds comprising providing transition metal complexes containing the compounds of the formula (I) which have been prepared according to Claim 8.
19. A process for preparing stereoisomerically enriched compounds comprising providing transition metal complexes containing the compounds of the formula (I) which have been prepared according to Claim 12.
- 20 20. Process for preparing stereoisomerically enriched compounds by asymmetric synthesis, comprising providing as catalysts transition metal complexes containing the compounds of the formula (I) which have been prepared according to Claim 8..
- 25 21. Process for preparing stereoisomerically enriched compounds by asymmetric synthesis, comprising providing as catalysts transition metal complexes containing the compounds of the formula (I) which have been prepared according to Claim 12.